Air Emissions

Stamatis Fradelos | December 2017
Leer | Hamburg

The following presentation is for informational use only. The actual costs for vessel compliance with the Global 0.50% Sulphur Limit may vary significantly based on each vessel's unique circumstances and the options chosen to achieve compliance

Prevention of Air Emissions

- Regulation 12 – Ozone Depleting Substances (ODS)
- Regulation 13 – Nitrogen Oxides (NOx)
- Regulation 14 – Sulfur Oxides (SOx) and Particulate Matter
- Regulation 15 – Volatile Organic Compounds (VOCs)
- Regulation 16 – Shipboard Incineration
- Regulation 21 – CO_2 by means of Required EEDI
- Regulation 22A – CO_2 by means of Data Collection System

For Engines Output > 130 kW
- Ships KL ≥ 1 Jan. 2000 < Jan. 1, 2011 – Tier I
- Ships KL ≥ Jan. 1, 2011 – Tier II
- Ships KL ≥ Jan. 1, 2016 – meet:
  - Tier II outside ECA
  - Tier III in ECA

Annex VI Special Areas	Ammendments to MARPOL	Entry into force of amendments	In effect from
Baltic Sea (Sox)	Sept. 26, 1997	May 19, 2005	May 19, 2006
North Sea (Sox)	July 22, 2005 (MEPC.132(53))	Nov. 22, 2006	Nov. 22, 2007
North American (SOx, and Nox and PM)	Mar. 26, 2010 (MEPC.190(60))	Aug.1, 2011	Aug. 1, 2012
Caribbean Sea(SOx, and Nox and PM)	July 15, 2011 (MEPC.202(53))	Jan. 1, 2013	**Jan. 1, 2014**

- < July 1, 2010: 1.5% S in ECA
- ≥ July 1, 2010: 1.0% S in ECA
- < Jan. 1, 2012: 4.5% S
- ≥ Jan. 1, 2012: 3.5% S
- ≥ Jan. 1, 2015: 0.1% S in ECA
- ≥ Jan. 1, 2020: 0.5% S Global

- Ships Contract ≥ 1 Jan. 2013 : meet EEDI
- Ships KL ≥ July 1, 2013 (In absence of contract date): meet EEDI
- Delivered ≥ July 1, 2015

- All Ships in international Voyages ≥ 5,000 GT
- Starting 1 January 2019

ABS

Regulatory Framework: Emissions

IMO MARPOL Annex VI

- Gaseous Emissions
- DCS
- GHG

- Regulation 14 – Sulfur Oxides (SOx) and Particulate Matter

- < 1 Jan. 2012: 4.5% S
- ≥ 1 Jan. 2012: 3.5% S
- ≥ 1 Jan. 2015: 0.10% S ECA
- ≥ 1 Jan. 2020: 0.5% S Globally

EU

- Monitoring, Reporting and Verifying CO2 Emissions EU Reg. 2015/57
- Sulfur Directive 1999/32/EC as amended…2012/33/EU

CARB (California Air Resource Board)

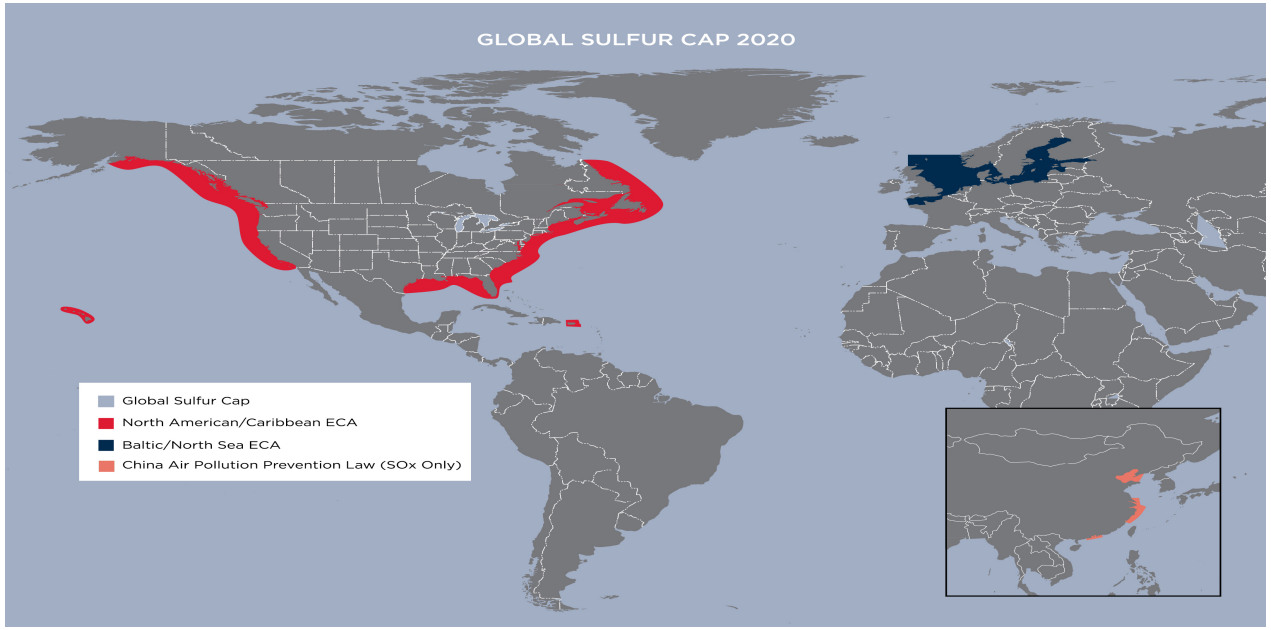
- Oceangoing Vessel (OGV) fuel regulation

EPA

- 40 CFRs

CHINA

- China Air Pollution Prevention Law



NOx, SOx, PM: Reduction Potential Solutions

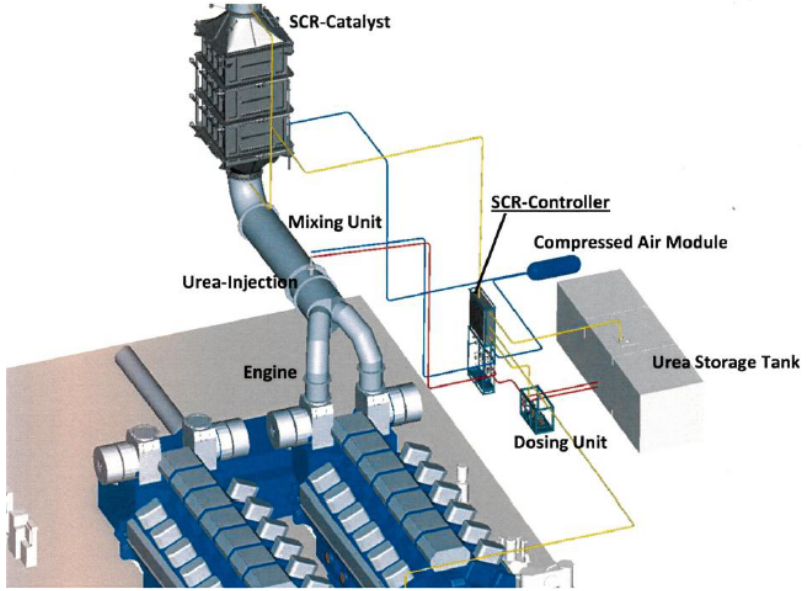
Technology	NOx	SOx	CO_2	PM
Use LNG as fuel	yes	yes	yes	yes
Infrastructure measures (i.e cold ironing)	yes	yes	yes	yes
Selective Catalytic Reduction (SCR)	yes	-	-	-
Exhaust Gas Recirculation (EGR)	yes	-	-	-
Exhaust Gas Cleaning System (EGCS)	-	yes	-	yes
Switching to low sulphur fuel oil	-	yes	-	yes

- \- Means negative, negligible or positive effect

ABS

NOx: Selective Catalytic Reduction (SCR)

- Consists of:
  - Reducing agent storage tank
  - Reducing agent feeding/dosing unit
  - Injector and mixer
  - Reactor with catalyst elements
  - A control system
- The reducing agent used is often a water solution (40%) of urea ($CO(NH_2)_2$)
- Urea is not defined as a hazardous material, but as it has corrosive effects, the tank must be made of a suitable material
- Concerns
  - Urea slip
  - Catalyst fouling



(1) $CO(NH_2)_2 \rightarrow NH_3 + HNCO$

(2) $HNCO + H_2O \rightarrow NH_3 + CO_2$

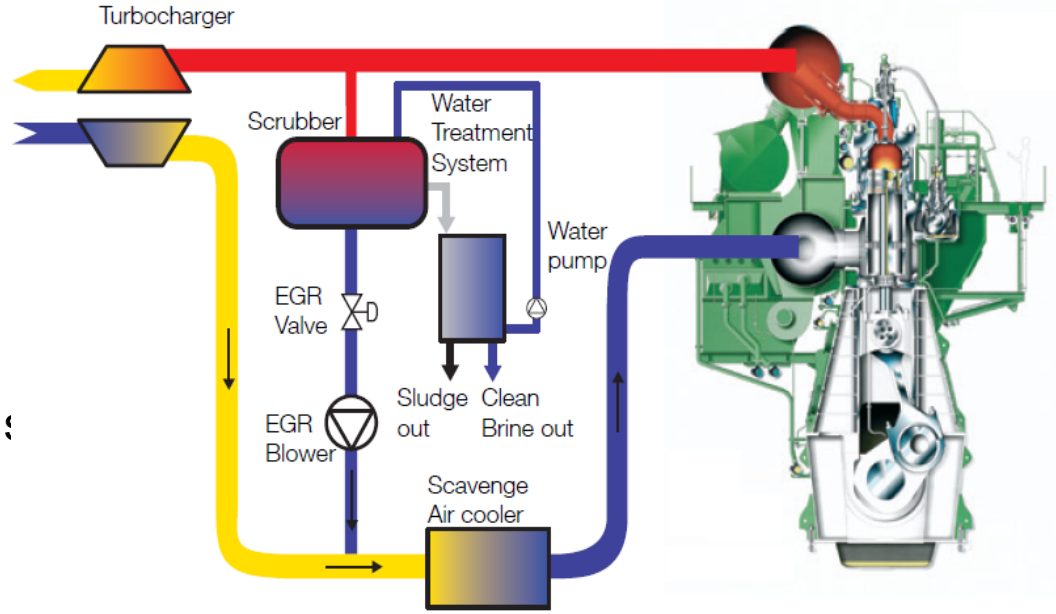
(3) $4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$

(4) $6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$

- The catalyst elements are normally dimensioned according to the need to meet the expected catalyst lifetime of 3 to 6 years or 12,000 to 24,000 running hours
- SCR needs exhaust temperatures > 300°C for catalytic reaction and below 450°C to avoid SO3 formation and thermal damage

NOx: Exhaust Gas Recirculation (EGR)

- EGR was first considered for marine-2-stroke-development in the early 1980s
- Recirculation of a portion of the exhaust gases, typically 20 to 40%
- Lowered amounts of oxygen and increased heat capacity result in decreased combustion temperatures which reduce the NOx formation
- Mainly consists of a:
  - Exhaust gas wet scrubber
  - A control valve
  - A high pressure blower
  - A water treatment system
  - A control unit for controlling the water treatment s
  - A NaOH dosing system
  - Sludge tank



- Specific SFOC increase: 1-2g/kWh at all loads
- Scrubber of the EGR system has to comply with the washwater discharge criteria, of IMO Resolution MEPC.259(68)

Consistent Implementation of the Global 0.50% Sulphur Limit

- A new work program included in the PPR S/C agenda for 2018-2019:
  - Transitional issues when shifting to the 0.50% m/m sulphur limit
  - Possible impact on fuel and machinery systems
  - Verification/control actions to ensure compliance
  - Standard format for reporting fuel oil non-availability
  - Guidance to assist stakeholders in assessing the sulphur content of fuel oil delivered to the ship
  - Safety implications with regard to using blended fuels to meet the 0.50% sulphur limit
  - Any consequential regulatory amendments and/or guidelines needed to address the above issues
- ISO has also been requested to consider the framework of ISO 8217 with a view to ensure consistency between the relevant ISO standards on marine fuel oils and the Implementation of the global 0.50% sulphur limit

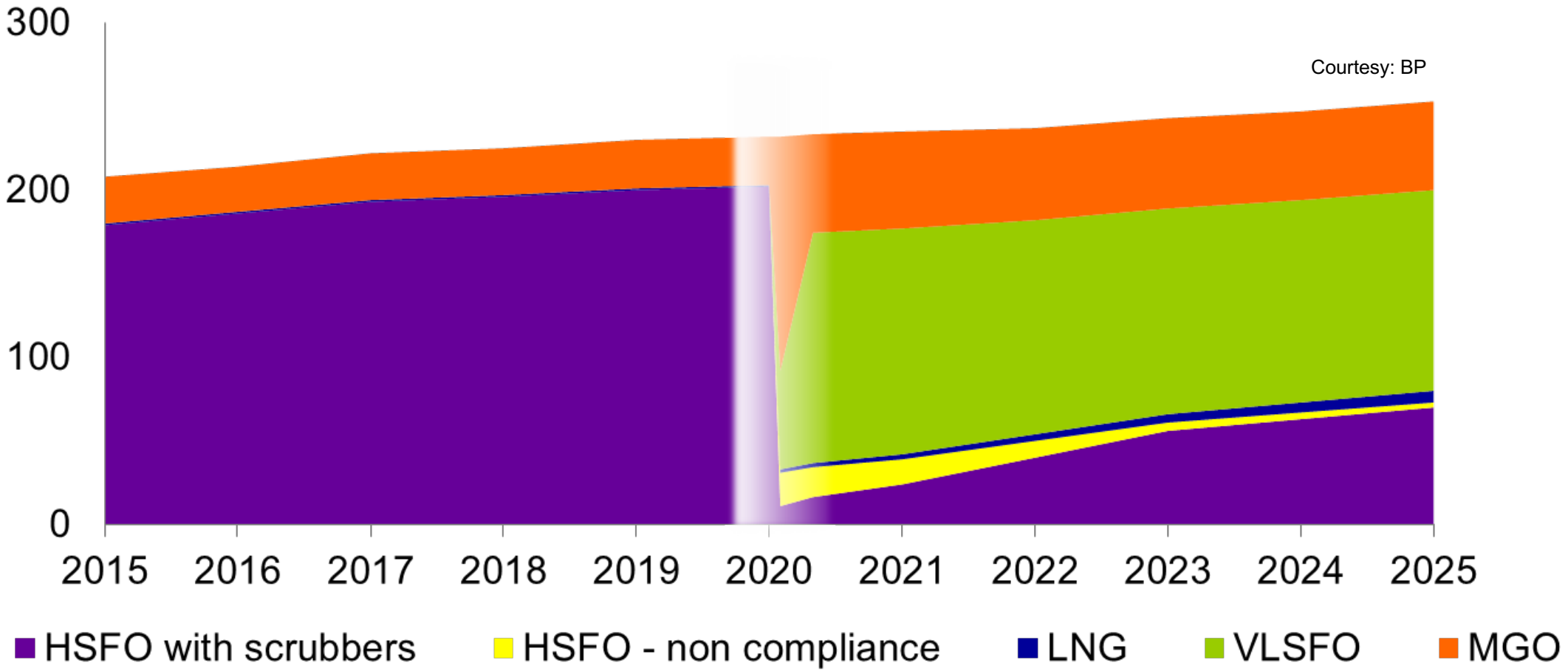
Pros and Cons Among Different Options

Fuels/Technologies	Pros	Cons
Low sulphur distillate fuels	• Widely used with few limitations • Very low CAPEX and small modifications	• Price difference compared to HFO • Low viscosity and lubricity • Existing vessels need modifications in FO storage, systems, boiler, etc.
Low sulphur heavy fuel oil	• Price expected lower than distillate fuel oil • No modifications required for existing vessels • Low Sulphur content, but behaves like HFO (heated fuel, higher viscosity)	• Limited availability
Blended 0.5% S fuel	• Price expected lower than distillate fuel oil	• Limited availability • Not yet categorized as per ISO 8217 • Compatibility/Stability issues

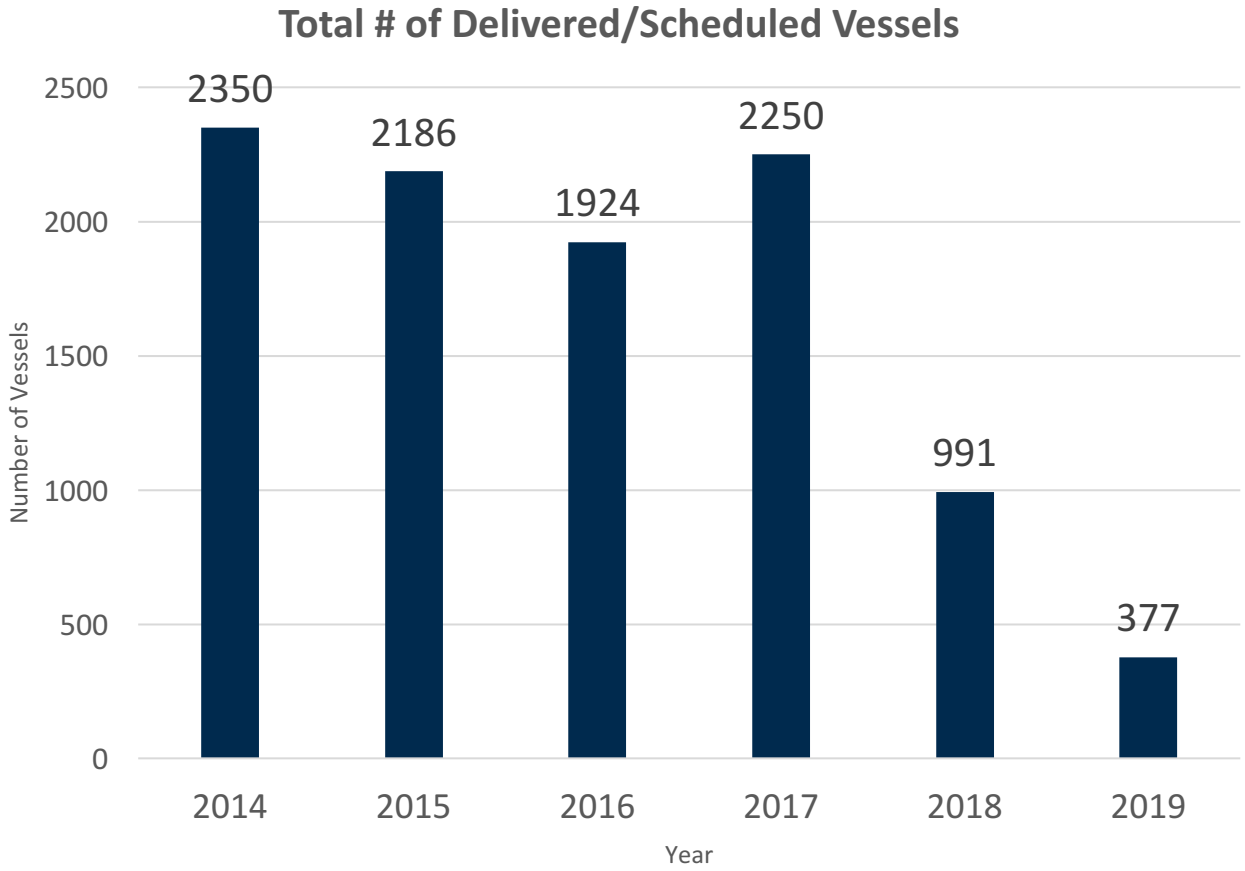
Pros and Cons Among Different Options

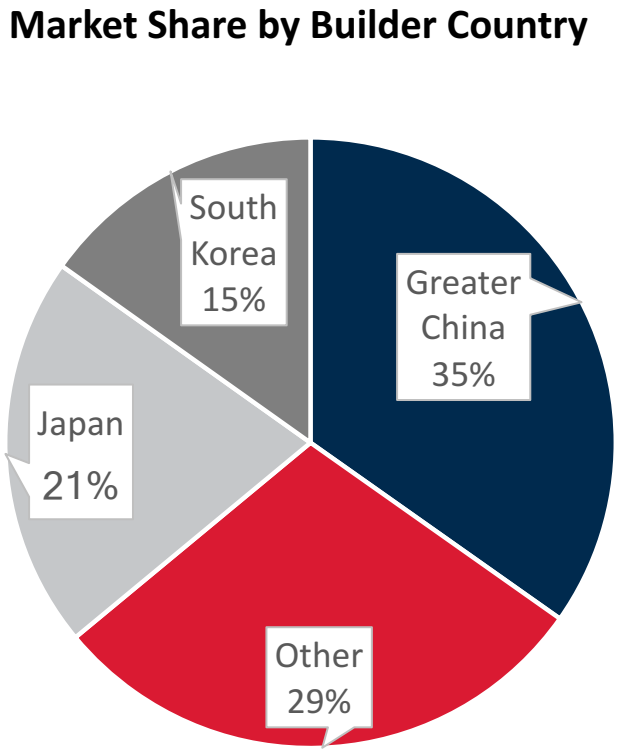
Fuels/Technologies	Pros	Cons
Exhaust Gas Cleaning Systems (EGCS)	• Reduces both SO_X and PM • Continue using low cost HFO • Pay back period accelerated with high price differential	• High installation costs • Relatively new technology • Limitations on washwater discharge • Fuel oil availability after 2020?
Liquefied Natural Gas (LNG)	• Very clean fuel meets 0.1% SO_X requirements • Low operating costs	• High CAPEX • Limited LNG bunkering infrastructure • Lower energy density-need higher volume tank
Alternative Fuels (LPG, CNG, Ethane, Methanol, Bio-Fuel, Solar Power, Fuel Cells)	• Cleaner fuels pose no issues to meet SO_X requirements	• Very new technologies and few applications are currently available • Some technologies are still in research and development stages

Global Marine Bunker Use



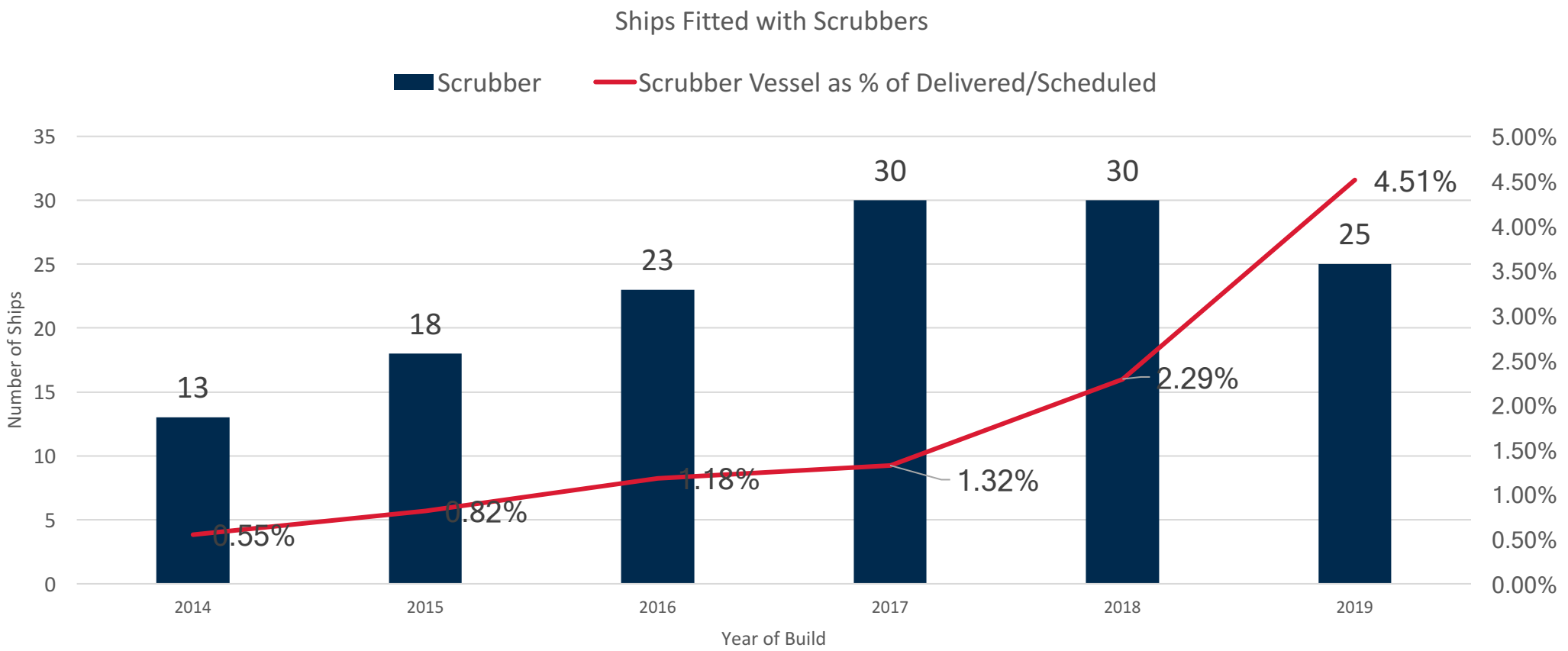
New Constructions Trends





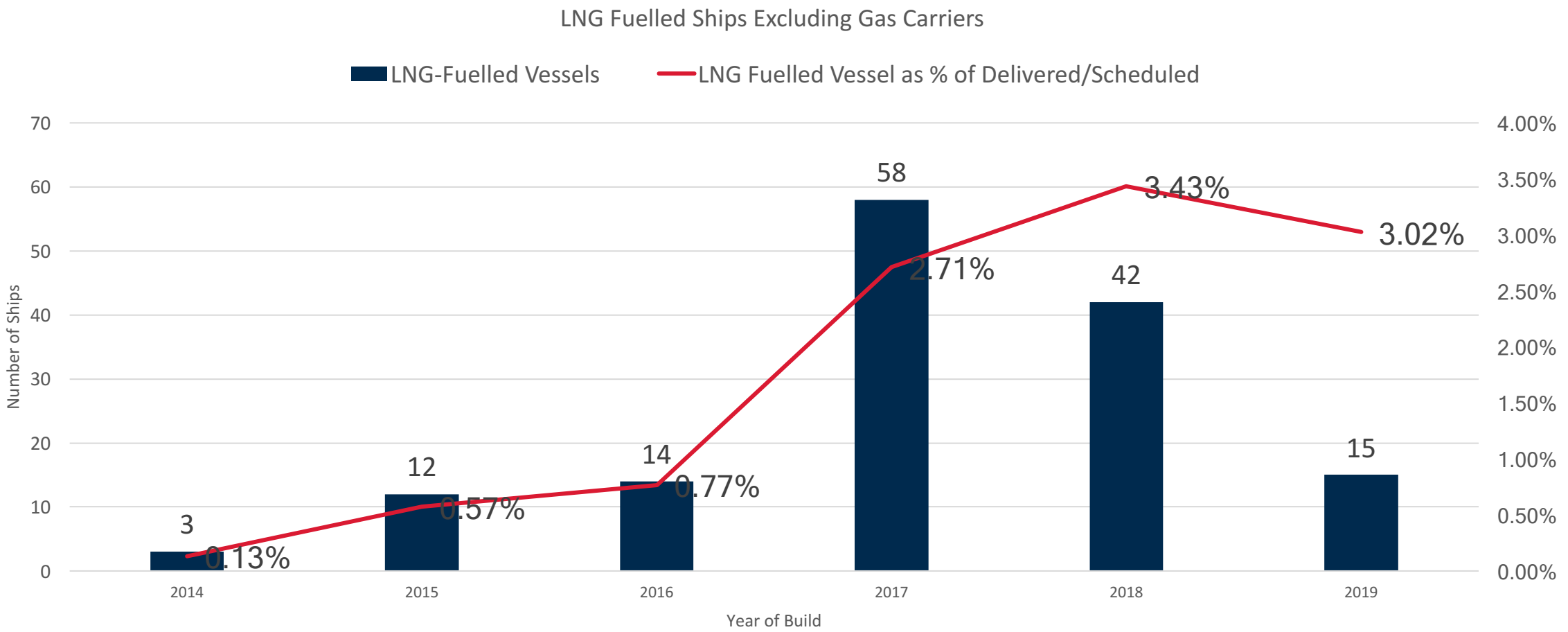
Source: **Clarkson Research 2017**

Projected # of Vessels Fitted with Scrubbers for 2018 - 2019



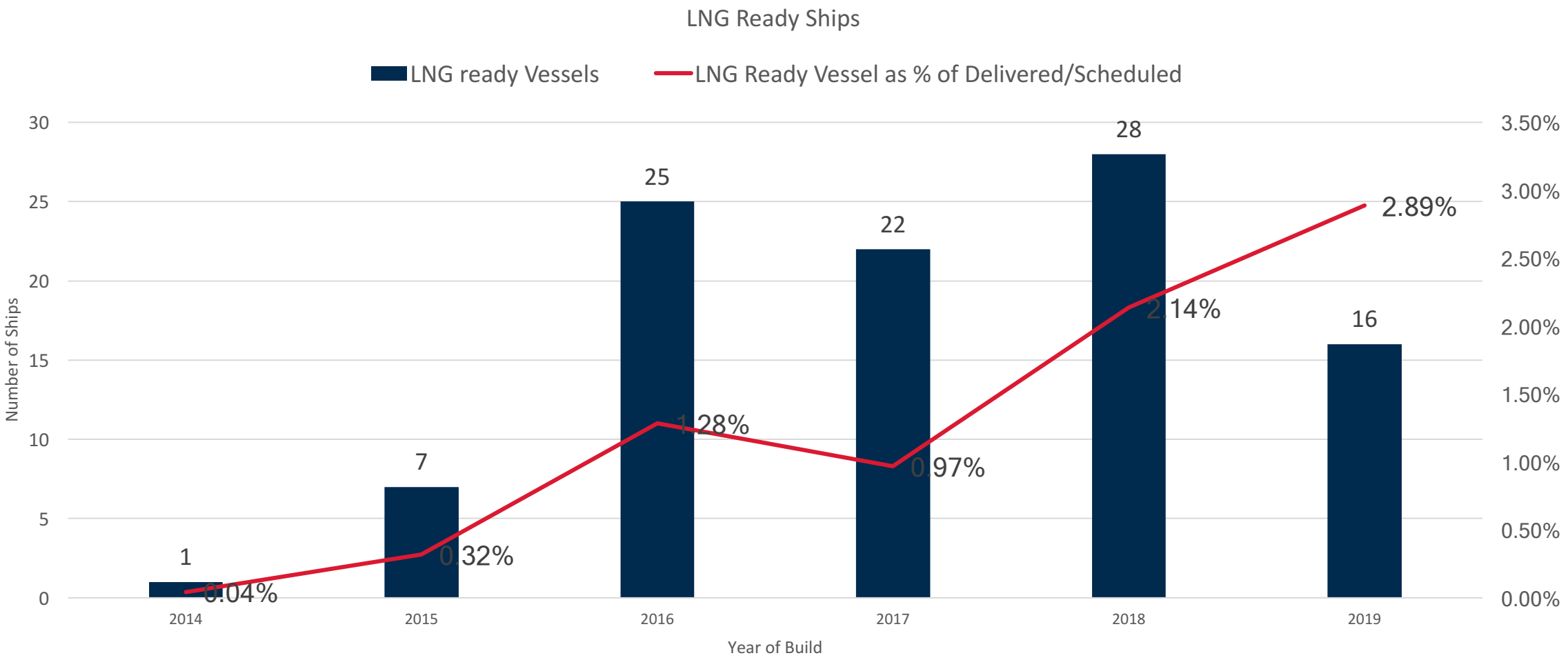
Source: **Clarkson Research 2017**

Projected # LNG-Fuelled Vessels Excluding Gas Carrier for 2018 - 2019



Source: **Clarkson Research 2017**

Projected # LNG Ready Vessels for 2018 - 2019



Source: **Clarkson Research 2017**

General Assumptions - CAPEX

SOX EGCS (Scrubbers)

	TANKER – SUEZMAX		
CAPEX	M/E Only	M/E + A/E	M/E + A/E + A/B
Open Loop	$1,380,000	$1,580,000	$1,910,000
Hybrid	$1,650,000	$1,900,000	$2,458,000

	BULK CARRIER - CAPESIZE		
CAPEX	M/E Only	M/E + A/E	M/E + A/E + A/B
Open Loop	$1,490,000	$1,540,000	$1,850,000
Hybrid	$1,550,000	$1,730,000	$2,090,000

	GAS CARRIER		
CAPEX	M/E Only	M/E + A/E	M/E + A/E + A/B
Open Loop	$1,280,000	$1,400,000	$1,630,000
Hybrid	$1,600,000	$1,780,000	$1,900,000

- **Installation costs:**
  - 100 to 140% of CAPEX
- **Design and Class costs**:
  - $125,000 Open Loop, $150,000 Hybrid

LNG as Fuel

	LNG CONVERSION - Machinery		
Item	Q/ty	Unit Cost	Total Cost
Total Cost	1	$2,500,000	$2,500,000

	LNG CONVERSION - Storage		
Item	Q/ty	Unit Cost	Total Cost
Tank	2	$1,500,000	$3,000,000
Gas Handling	1	$1,500,000	$1,500,000
Install. Cost	2	$625,000	$1,250,000
Total Cost			$5,750,000

	LNG CONVERSION - Outfit		
Item	Q/ty	Unit Cost	Total Cost
GVU Rooms	5	$100,000	$500,000
Double Wall Pipe	3	$100,000	$300,000
Vent Riser & Mast	2	$200,000	$400,000
Bunker Sta. & Pipe	2	$100,000	$200,000
Venilation	1	$300,000	$300,000
Total			$1,700,000
Total CAPEX			**$9,950,000**

LPG as Fuel

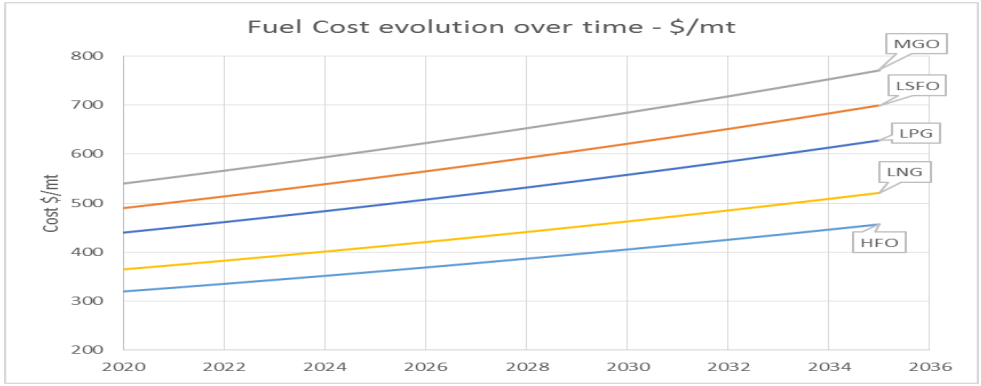
	LPG CONVERSION - Machinery		
Item	Q/ty	Unit Cost	Total Cost
M/E Cost	1	$1,000,000	$1,000,000

	LPG CONVERSION - Storage		
Item	Q/ty	Unit Cost	Total Cost
Total Cost	1	$1,000,000	$4,000,000

	LPG CONVERSION - Outfit		
Item	Q/ty	Unit Cost	Total Cost
Total Cost	1	$1,000,000	$1,000,000
Total CAPEX			**$6,000,000**

General Assumptions - OPEX

- System Life expectancy of system 15 years
- Initial Fuel Cost 2020 (2.4% annual increase):
  - HFO: $320/mt, LSFO: $490/mt, MGO: $540/mt.
- Scrubber OPEX
  - Additional 1% M/E Fuel consumption due to increased back pressure
  - 1 to 1.3t/day extra consumption due to the additional electrical load
  - Caustic Soda Cost: $250 per ton and $2,500 per bunkering
  - Maintenance: 2% of CAPEX per year for open loop and 3% for Hybrid
  - Service Engineer and Crew training: $15,000 per year
  - Cost of cargo lost due to system weight:
    - Tanker: 46U.S.$/t approx. 650 U.S.$/year
    - Bulk Carrier: 32U.S.$/t approx. 450 U.S.$/year
    - Gas Carrier: 135U.S.$/t approx. 1,750 U.S.$/year
  - Extra 4.1 t of CO2 emitted per day (assuming a CO2 Tax 10 U.S.$/tonne CO2)
    - Tanker: 9,700 U.S.$/year
    - Bulk Carrier: 11,100 U.S.$/year
    - Gas Carrier: 8,600 U.S.$/year (based on 3.1t of CO2 emitted per day)



LNG as fuel:$365/mt equivalent to 1 mt MGO

LNG Cost Calculation	
Commodity Cost	3.5$/GJ
Liquefaction Service	4$/GJ
Total	7.5$/GJ
Cost per MGO equiv.	318.75$
Convert to NCV	347.76$

LPG as fuel: 440 $/mt equivalent to 1 mt MGO

- M/E consumption 10% lower

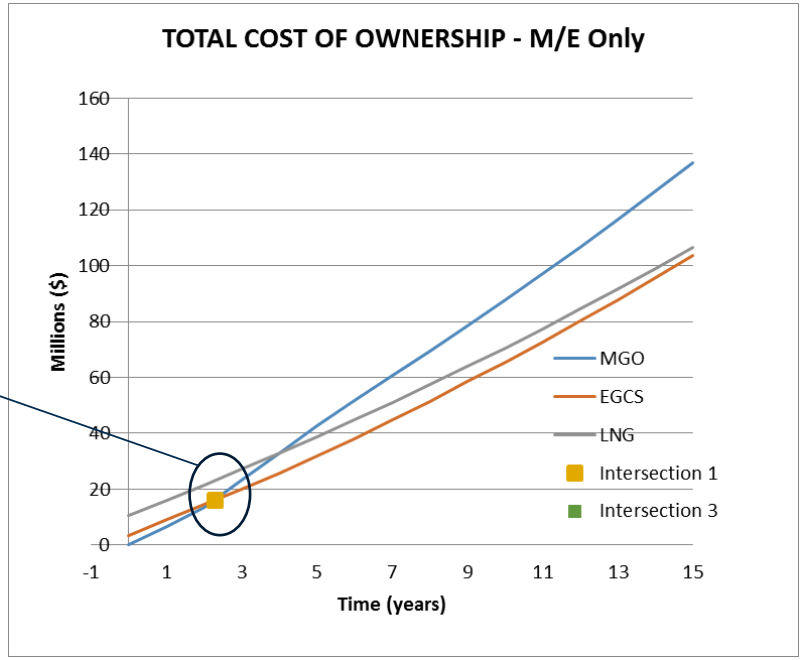
EGCS LCCA Results

- Simple Payback Period:

Open Loop EGCS	TANKER – SUEZMAX SPP	BULK CARRIER – CAPESIZE SPP	GAS CARRIER – SPP
M/E	1.84	1.34	1.49
M/E and A/E	1.96	1.23	1.26
M/E, A/E and A/B	2.05	1.60	1.45

- Discounted Payback Period:

Open Loop EGCS	TANKER – SUEZMAX DPP	BULK CARRIER – CAPESIZE DPP	GAS CARRIER – DPP
M/E	1.9	1.4	1.5
M/E and A/E	2.0	1.2	1.3
M/E, A/E and A/B	2.1	1.6	1.5



EGCS LCCA Results (Cont.)

- Life Cycle Cost Analysis indexes:

	TANKER - SUEZMAX			BULK CARRIER - CAPESIZE			GAS CARRIER		
Open Loop	M/E Only	M/E and A/E	M/E, A/E and A/B	M/E Only	M/E and A/E	M/E, A/E and A/B	M/E Only	M/E and A/E	M/E, A/E and A/B
ROI (% per year)	52.03	48.81	46.59	71.45	77.82	59.76	63.34	75.39	65.43
NS	$18,357,354	$19,475,032	$22,211,897	$26,858,283	$30,369,622	$29,724,988	$28,374,403	$37,190,391	$37,102,908
SIR	8.3	7.8	7.5	11.4	12.5	9.6	13.3	15.8	13.7
AIRR	18.6	18.1	17.8	21.2	21.9	19.7	17.2	18.3	17.4

- ROI (Return On Investment - % per year) → (Annual Profit x 100) / Capital Investment
- NS (Net Savings) → NS is a current value expressing the net lifecycle benefit after costs are subtracted
- SIR (Savings to Investment Ratio) → Present Value of Operational Saving/ Present Value of Additional Investment Cost
- AIRR (Adjusted Internal Rate of Returns) → ((1+r)*(SIR)^1/N)-1 with r the rate of reinvestment and N the number of anticipated lifetime of the investment (15 years in this case). A measure of annual percentage yield from an investment

LNG and LPG as Fuel Results

LNG Results for the Vessels:

- Discounted Payback Period:

LNG Conversion	TANKER - SUEZMAX DPP
M/E, A/E and A/B	4.7

- Life Cycle Cost Analysis indexes :

LNG Conversion	TANKER - SUEZMAX
ROI (% per year)	20.80
NS	$18,307,474
SIR	3.3
AIRR	11.6

LPG Results for the Vessels:

- Discounted Payback Period:

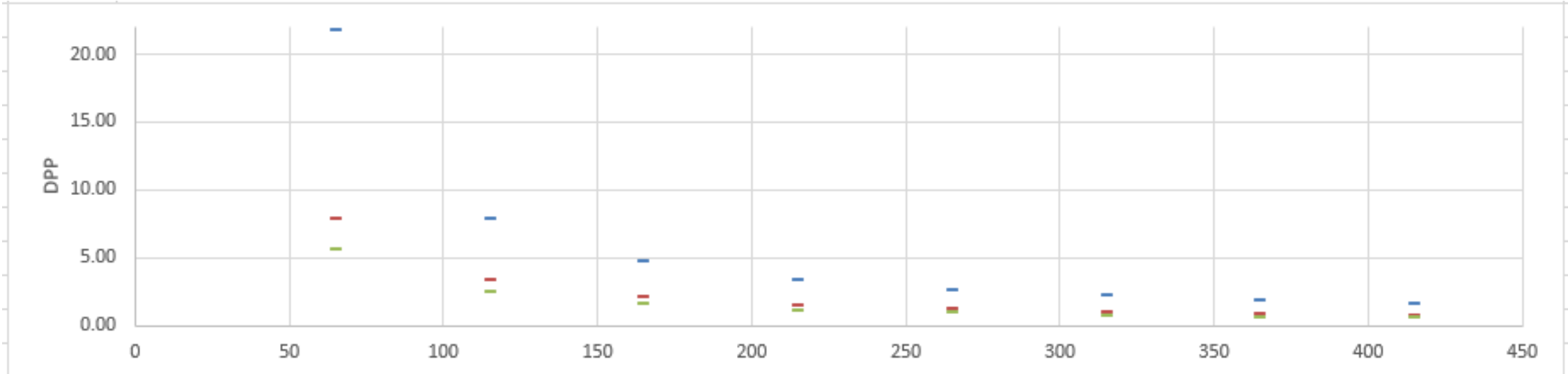
LPG Conversion	GAS CARRIER - DPP
M/E	3.8

- Life Cycle Cost Analysis Indexes:

LPG Conversion	GAS CARRIER
ROI (% per year)	25.18
NS	$19,090,955
SIR	5.3
AIRR	11.9

Tanker – Suezmax – Sensitivity to No. of Days at Sea

- Effect on Discounted Payback Period from varying the HFO/LSFO differential and the annual days at sea from 110 to 310, for the M/E only EGCS



	HFO/LSFO	65	115	165	215	265	315	365	415
Low	110.00	21.76	7.85	4.73	3.38	2.63	2.15	1.82	1.57
Ref	235.00	7.83	3.27	2.06	1.51	1.19	0.98	0.83	0.72
High	310.00	5.53	2.41	1.54	1.13	0.89	0.74	0.63	0.55

Bunker Delivery Note (BDN)

- MEPC72 adopted revisions to Appendix V of MARPOL Annex VI (information to be included in the BDN)
- Now allows for the option to document the sulphur content specified by the purchaser which may exceed relevant limit values:
  - for use on ships fitted with SOx abatement equipment
  - or undergoing emission reduction and control technology research.
- The amendment enters into force on January 1, 2019

Appendix V
Information to be included in the bunker delivery note (regulation 18.5)

The items listed in the Appendix are numbered from 1 to 9.

In item 7, the comma after "15˚C" is deleted and brackets are added around "kg/m^3".

Item 9 is replaced with the following:

"A declaration signed and certified by the fuel oil supplier's representative that the fuel oil supplied is in conformity with regulation 18.3 of this Annex and that the sulphur content of the fuel oil supplied does not exceed:

☐ the limit value given by regulation 14.1 of this Annex;

☐ the limit value given by regulation 14.4 of this Annex; or

☐ the purchaser's specified limit value of _____ (% m/m).
As completed by the fuel oil supplier's representative and on the basis of the purchaser's notification that the fuel oil is intended to be used:

.1 in combination with an equivalent means of compliance in accordance with regulation 4 of this Annex; or

.2 is subject to a relevant exemption for a ship to conduct trials for sulphur oxides emission reduction and control technology research in accordance with regulation 3.2 of this Annex.

This declaration shall be completed by the fuel oil supplier's representative by marking the applicable box(es) with a cross (x)."

Vessel General Permit

- No sludge or residue discharge in VGP waters
- Applies IMO washwater discharge criteria except min. pH 6.0 at overboard discharge is only option. During maneuvering and transit, the maximum difference between inlet and outlet of 2.0 pH units is allowed.
  - Require continuous monitoring pH, PAH (as available), turbidity and temperature.
- **A computational calculation is not an approved method for demonstrating compliance with VGP pH requirements.**
- Includes sampling and monitoring obligations,
  - Three samples locations - inlet water, washwater after the scrubber but before treatment, and discharge water
  - Sampling twice 1st year and once from the 2nd year.
- **Vessel operators cannot use dilution as a substitute for treatment for the purpose of meeting effluent limitations.**

Analysis	Method
Dissolved and Total Metals	EPA Method EPA-200.8 or EPA-200.9
PAHs	EPA Method EPA-550.1, EPA-610, EPA-625, EPA-8100, EPA-8270c or EPA-8310
Nitrate/Nitrite	EPA Method EPA-353.2
pH	Standard Method SM 4500-H B

Flow Rate (t/MWH)	Discharge Concentration Limit (mg/L nitrate + nitrite)
0 - 1	2,700
2.5	1,080
5	640
11.25	240
22.5	120
45	60
90	30

Nitrates + Nitrites Permit Limits in the Discharge

USCG Guidance

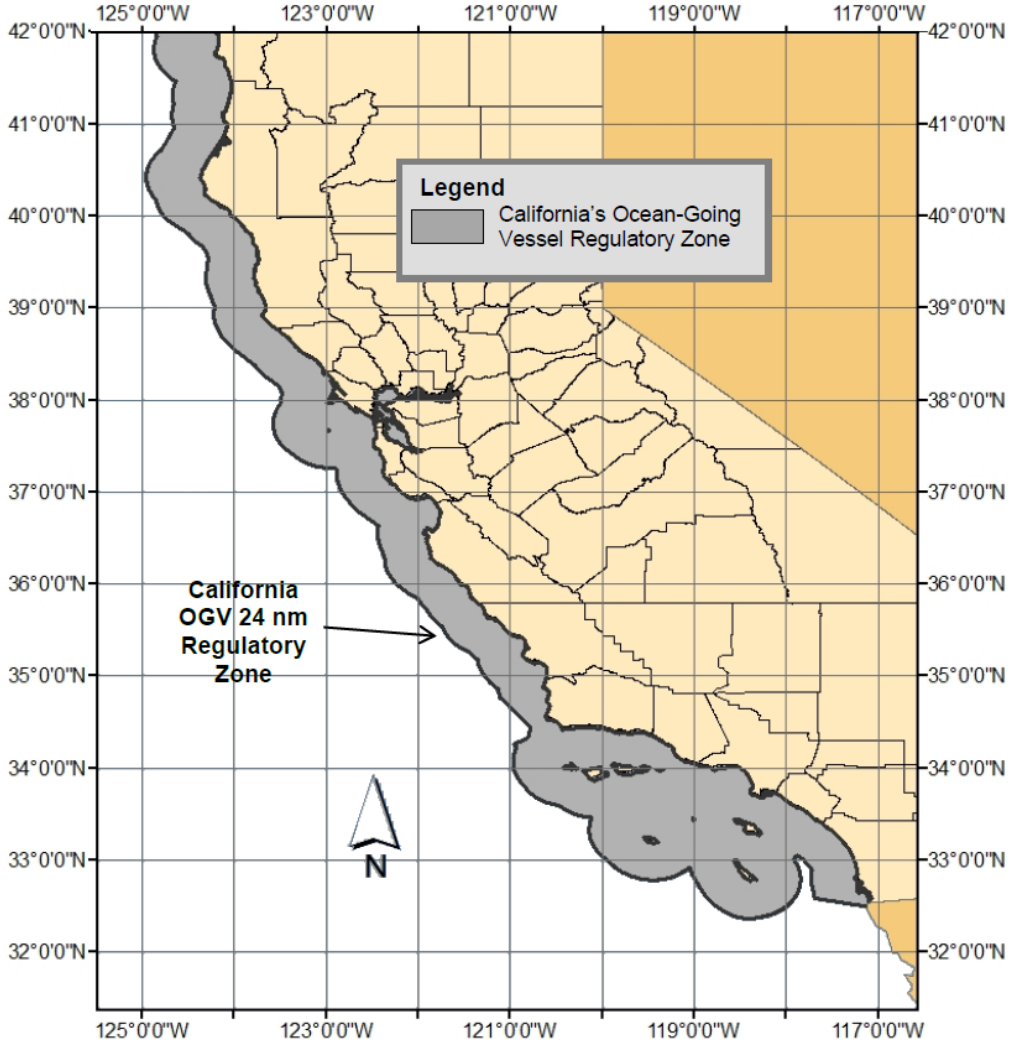
- USCG has published guidelines for enforcement of MARPOL Annex VI Regulation 14 under CG-CVC Policy Letter No. 12-04 dated 25 July 2012
- Requires foreign flags approving EGCS as equivalent to submit copy to USCG for review/acceptance
- Expects a “degree of redundancy”

ii. **Foreign flagged ships.** The Coast Guard and EPA have collectively submitted correspondence to the Secretary-General, International Maritime Organization (IMO) outlining the U.S. Government’s concerns regarding MARPOL Annex VI, Regulation 4. This correspondence emphasized the importance that flag Administrations coordinate with ECA states before approving equivalencies. This approach is intended to minimize the need for imposing control or enforcement actions against an owner/operator if the U.S. Government does not concur with the ships flag Administration regarding compliance with the ECA requirements. Until additional guidelines are developed at the IMO, the U.S. Coast Guard as the Administration for the United States requests a flag Administration considering an equivalency under Annex VI, Regulation 4, to submit a copy of the proposal to the USCG for review/acceptance. Proposals may be submitted to the Coast Guard at the following address: Commandant (CG-CVC-2); Attn: MARPOL Annex VI; 2100 2nd Street S.W., Stop 7581; Washington DC 20593-7581 or via email to ECA-foreignflag@uscg.mil. The e-mail subject line should include the following text: Flag Administration (e.g., Bahamas Flag) – ECA Equivalent Controls – Vessel Name – IMO#.

6. Equipment casualty or failure. MARPOL Annex VI, regulation 3 allows for exception and exemptions, and specifically, regulation 3.1.2, allows for non-compliant emissions resulting from damage to a ship or its equipment. Furthermore, Annex VI, regulation 5.5 states, “whenever an accident occurs to a ship or a defect is discovered that substantially affects the efficiency or completeness of its equipment covered by this Annex, the master or owner of the ship shall report at the earliest opportunity to the Administration, a nominated surveyor or recognized organization responsible for issuing the relevant certificate.” When equipment approved by an Administration under Annex VI Regulation 4 (equivalency – e.g., scrubber) for complying with the standards set forth in Regulation 13 and 14, experiences a failure the Coast Guard expects a certain degree of redundancy so that the ship may continue to operate in compliance with Regulation 13 or 14 (*e.g. pumps, available spare parts onboard, or alternative arrangements (e.g. Low Sulfur Fuel Oil tanks)*). The Coast Guard will take into consideration a ship which has reported an accident or a defect in accordance with Annex VI, regulation 5.5 whose flag Administration (or their representative) has issued an interim compliance scheme and an outstanding condition due to equipment casualty or failure.

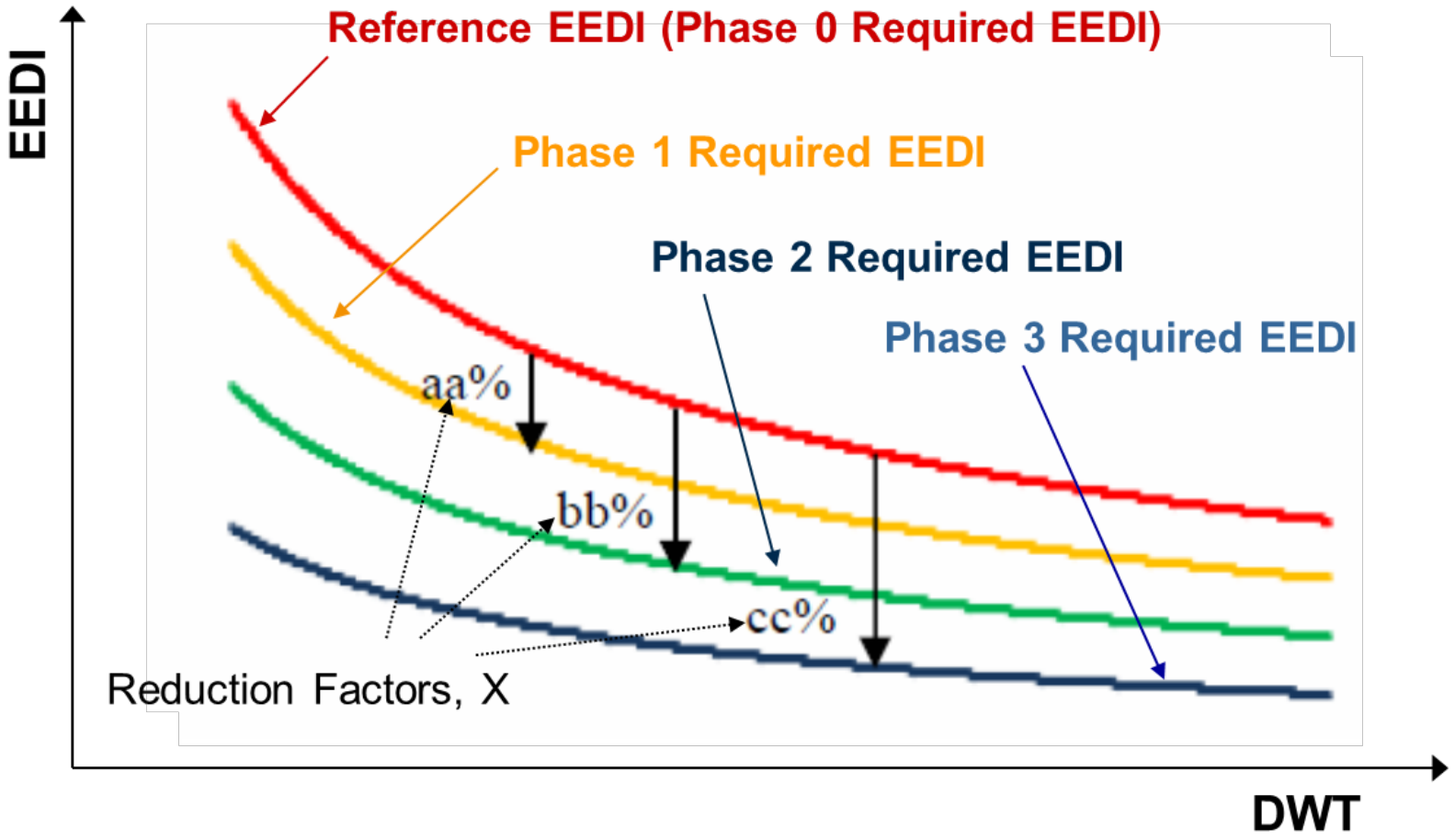
CARB Guidance

- CARB has permitted the use of ECA compliant non-distillate low sulfur fuel or equivalent alternative emission control technologies (e.g. scrubber) under a ‘Research Exemption’ criteria (exemption during the “sunset review period”).
- Applications must be submitted at least thirty days prior to entering Regulated California Waters.



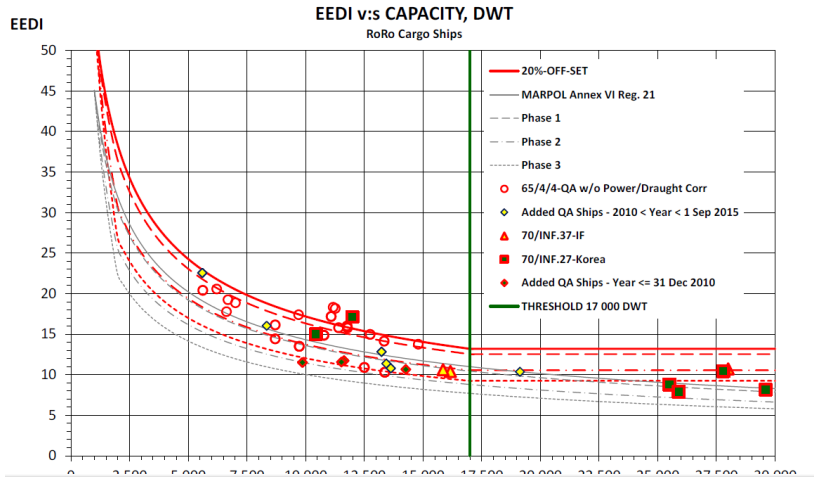
Required EEDI

- IMO to review status of technology development and revise EEDI Reference Line parameters and Reduction Factors (Reg 21.6)
  - At beginning of Phase 1
  - at midpoint of Phase 2



EEDI reviews under Reg. 21.6

- Ro-ro cargo and ro-ro passenger ships - MEPC 71/5/14



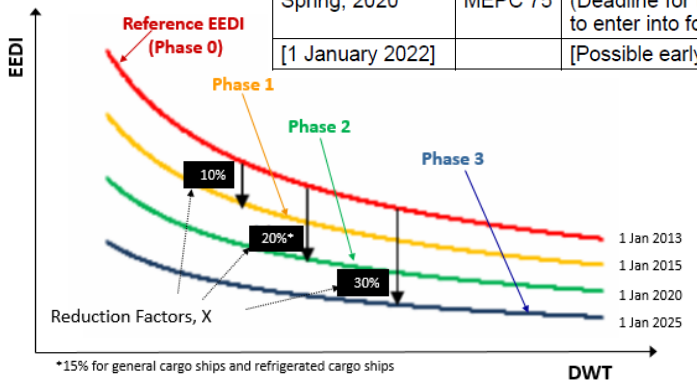
"Table 2. Parameters for determination of reference values for the different ship types

Ship type defined in regulation 2		a	b	c
…				
2.34	Ro-ro cargo ship	~~1405.15~~ 1686.17	DWT of the ship where DWT ≤ 17,000 17,000 where DWT > 17,000	0.498
2.35	Ro-ro passenger ship	~~752.16~~ 902.59	DWT of the ship where DWT≤ 10,000 10,000 where DWT > 10,000	0.381
…				

EEDI reviews under Reg. 21.6

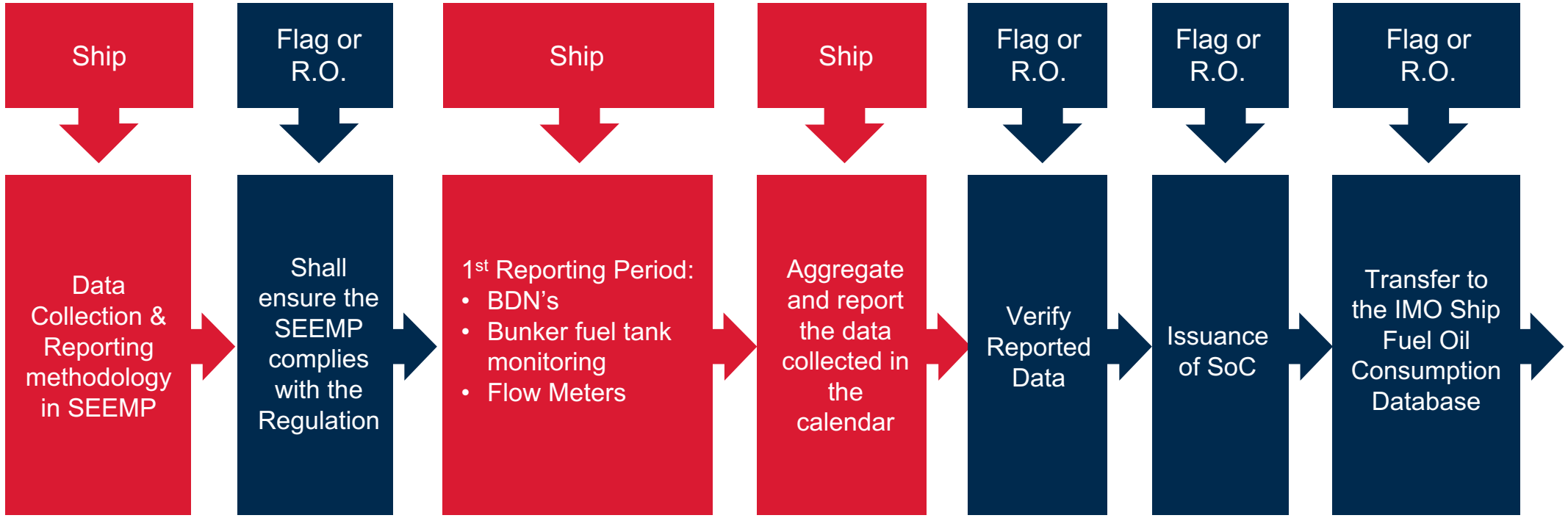
- EEDI review beyond phase 2 - MEPC 71/5/12
  - A CG established to review EEDI phase 3 requirements, with possibility:
    - Of advancing the phase 3 implementation date from 2025 to 2022 after resolving concerns about maintaining minimum propulsion power.
    - Consider whether a new set of phase 4 EEDI reduction rates should be introduced
  - The CG will also consider:
    - the necessity of amending attained EEDI calculation guidelines relating to ice classed ships
    - associated correction factors and application of EEDI requirements to ships with ice classes higher than IA Super.
  - The group is expected to complete its work and submit a final report to MEPC 74 in 2019.

July 2017	MEPC 71	Agree to terms of reference for a correspondence group for EEDI review. Establish a correspondence group for EEDI review.
Spring, 2018	MEPC 72	Consider the progress report of the correspondence group
Autumn, 2018	MEPC 73	[Consider the progress report of the correspondence group]
Summer, 2019	MEPC 74	Consider the final report of the correspondence group and decide accordingly.
(1 January 2020)		(Implementation date of phase 2)
Spring, 2020	MEPC 75	(Deadline for the adoption of an amendment for it to enter into force by 1 January 2022.)
[1 January 2022]		[Possible early implementation date of phase 3]



IMO Data Collection System (DCS)

- New Regulation 22A: Collection and reporting of ship fuel consumption data



IMO DCS STANDARDIZED DATA REPORTING FORMAT

STANDARDIZED DATA REPORTING FORMAT FOR THE DATA COLLECTION SYSTEM

Start date (dd/mm/yyyy)	End date (dd/mm/yyyy)	IMO number[1]	Ship type[2]	Gross Tonnage[3]	NT[4]	DWT[5]	EEDI (if applicable)[6] ($gCO_2/t.nm$)	Ice class[7] (if applicable)	Power output[8] (rated power) (kW)		Distance Travelled (nm)	Hours underway (h)	Number of passengers[9]	Fuel oil consumption (t)									Method used to measure fuel oil consumption[10]
									Main Propulsion Power	Auxiliary Engine(s)				Diesel/Gas Oil (C_f: 3.206)	LFO (C_f: 3.151)	HFO (C_f: 3.114)	LPG (Propane) (C_f: 3.000)	LPG (Butane) (C_f: 3.030)	LNG (C_f: 2.750)	Methanol (C_f: 1.375)	Ethanol (C_f: 1.913)	Other(……)	(C_f ;……)	

- Proposed amendments to add number of passengers to the standardized data reporting format
- Method used to measure fuel oil consumption:
  - Method using BDNs,
  - Method using flow meters,
  - Method using bunker fuel tank monitoring

Roadmap for IMO Strategy on Reduction of GHG Emissions

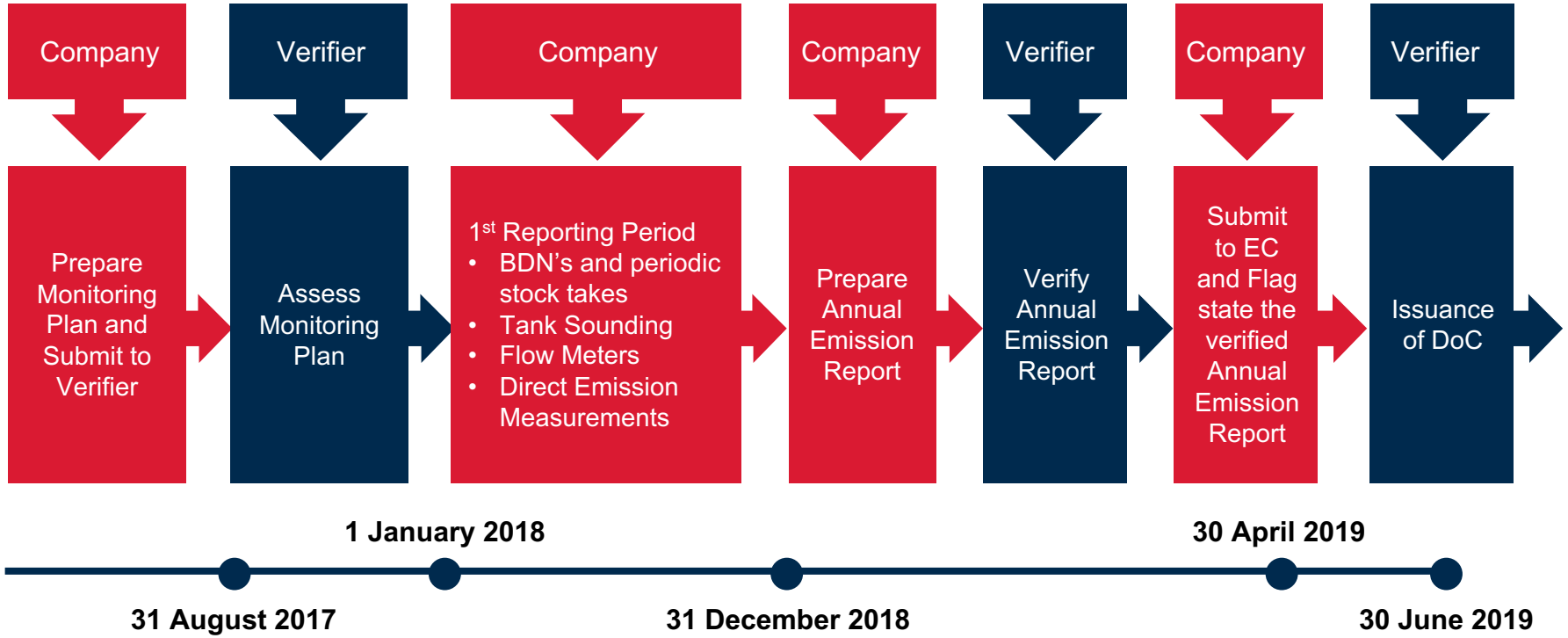
October 2016 (MEPC 70)	Adoption of Data Collection System (DCS) Approval of Roadmap
Week before MEPC 71	Intersessional meeting to start discussions on a comprehensive IMO strategy
July 2017 (MEPC 71)	Discussion continues
October 2017	Intersessional meeting
Week before MEPC 72	Intersessional meeting
Spring 2018 (MEPC 72)	**Adoption of initial IMO Strategy (including short-, mid- and long term measures)**
January 2019	Start of Phase 1: Data collection (Ships to collect data)
Spring 2019 (MEPC 74)	Discussion continues Initiation of Fourth IMO GHG Study using data from 2012-2018
Summer 2020	Data for 2019 to be reported to IMO

Roadmap for IMO Strategy on Reduction of GHG Emissions

Autumn 2020 (MEPC 76)	Start of Phase 2: data analysis (no later than autumn 2020) Publication of Fourth IMO GHG Study for consideration by MEPC 76
Spring 2021 (MEPC 77)	Initiation of work for adjustments on Initial IMO Strategy, based on DCS data
Summer 2021	Data for 2020 to be reported to IMO
Spring 2022 (MEPC 78)	Phase 3: Decision step Secretariat report summarizing the 2020 data
Summer 2022	Data for 2021 to be reported to IMO
Spring 2023 (MEPC 80)	**Adoption of Revised IMO Strategy (short-, mid- and long-term measures)** Secretariat report summarizing the 2021 data pursuant to regulation 22A.10

CO2: EU Monitoring, Reporting and Verification

- EC published proposal for CO2 emissions MRV Regulation on June 28, 2013
- Approved by EU Parliament on April 29, 2015 as Regulation (EU) 2015/757
- Entry into force: July 1, 2015
- Ships above 5,000 GT on voyages to, from and between EU ports



EC roadmap on the revision of the EU MRV Regulation

- EC published an inception impact assessment on the revision of the EU MRV in view of its alignment to the IMO Data Collection System:
  - **A. No alignment:** Two sets of data are to be monitored, two different verification approaches are applied and EU data are to be published.
  - **B. Full alignment:** The EU-MRV is fully aligned to the IMO data collection system but ships using EEA ports have to submit reports in both systems with the reports for the EU system only covering voyages from and to EEA ports.
  - **C. Partial alignment**: EU MRV is maintained, including all elements (monitoring, reporting, verification and publication). Similar elements are harmonised in order to minimize administrative burden.
- The Inception impact assessment and the feedback received are available:
  - http://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-3112662_en
- EC announced a public consultation on the revision of the policy on MRV:
  - https://ec.europa.eu/clima/consultations/articles/0032_en
  - The consultation period will run until 1st December 2017
- Publication of EC final proposal is being expected the 2nd quarter of 2018.

Thank You

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